THE UTILIZATION BY RATS OF THE ENERGY IN RIBOFLAVIN DEFICIENT DIETS

BY

JOSEPH BERNSOHN

B.S., Brooklyn College, 1938
M.S., University of Illinois, 1940

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
ANIMAL NUTRITION IN THE GRADUATE SCHOOL
OF THE UNIVERSITY OF ILLINOIS, 1943

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I. Introduction

The concept of the heat increment of nutrients and its relation to the balanced diet which has arisen in the past ten to twenty years, has gone a long way towards harmonizing the random, ofttimes seemingly contradictory, and usually inexplicable data obtained in studies concerned with food utilization from various laboratories. While support of such a concept has been forthcoming in the case of protein and mineral unbalance in the diet, the evidence in the case of vitamins has been less certain and less satisfactory.

This study is concerned primarily with the effect of a riboflavin deficiency on the utilization of food, with a view to ascertaining the effect of a riboflavin unbalance in the diet on the heat increment and so determining the validity of the aforementioned concept for a riboflavin deficient diet.

II. Experimental

The experimental work comprised a number of growth experiments in which either the diet or the level of riboflavin fed was varied. In addition, three series of rats were studied in which the digestibility and urinary excretion of energy and nitrogen, as well as the respiratory exchange, were measured. The first of these series involved a comparison of rats receiving a high carbohydrate diet containing no riboflavin with controls receiving 100 mcgms. per day. This test extended over twelve weeks and comprised three determinations of four weeks duration each, thus ranging from a mild to a severe deficiency. The second series involved a comparison of rats receiving 0.5 mcgm. riboflavin per gram of food as compared to controls receiving 5.0 mcgms. per gram of food, pair-mates

being fed so as to promote equal gains in weight, and the third series was a study of the effect of a high fat and high protein diet on ariboflavinosis, the reversal method of feeding being used. In addition, the effect of ariboflavinosis on the voluntary activity as well as on the composition of gains was studied, in both cases paired rats being fed so as to promote equal gains in weight.

III. Results and Discussion

Irrespective of the type of diet fed or the level of riboflavin in the diet a significant difference in growth was always obtained in comparing rats receiving a diet deficient in riboflavin with those receiving an adequate amount of riboflavin, the latter attaining the larger weight. That this difference was not due either to a difference in the voluntary activity or to the composition of gains put on, was also demonstrated.

The digestibility of energy and nitrogen was not affected by a moderate riboflavin deficiency, the apparent digestibility of nitrogen and energy being 93.3% and 97.6% in deficient animals as compared to 93.4% and 97.8% in controls. In a severe and prolonged deficiency a difference was obtained, the apparent digestibility for nitrogen being 93.0% in deficient rats as compared to 94.5%, and for energy 96.7% as compared to 97.4% in controls. Kon ('31), St. Julian and Heller ('35) and Braman *et al* ('35), all have reported no effect on digestibility on a riboflavin deficient diet. No difference in digestibility was found on a high protein diet, but a higher apparent digestibility of energy and nitrogen was found in deficient rats as compared to controls, on a high fat diet, the values being 95.1% and 89.4% in deficient animals, and 90.6% and 85.4% in controls.

The urinary excretion of nitrogen was not significantly different in a severe deficiency and when the animals were in negative nitrogen balance. An increased excretion of urinary energy was obtained in deficient animals, and thus an in-

creased cal.:N ratio, although the differences were not significant. In a moderate deficiency when the rats were in positive nitrogen balance, a statistically significant increase in urinary nitrogen was obtained in deficient rats as well as an increased urinary energy excretion and cal.:N ratio. For controls the values were 74.6 mgms. of nitrogen, 622 sm. cals. and a cal.:N ratio of 8.34, and for deficient rats the corresponding values were 79.4 mgms. nitrogen, 750 sm. cals. and 9.51. On high fat and high protein diets an increased excretion of nitrogen and energy was also obtained in the deficient state. Braman *et al* ('35) obtained no difference in urinary nitrogen, but did obtain an increased urinary energy in riboflavin-deficient rats, while Kleiber and Jukes ('42) found a difference in nitrogen retention in chicks. The results here obtained would substantiate the theory that riboflavin is concerned in protein anabolism.

Although a small but statistically significant difference of 9 Cals. per m^2 per 24 hours in basal metabolism was obtained in one series during the moderate deficiency, no other difference was obtained even during a severe deficiency, and it is concluded that ariboflavinosis has no marked effect on the basal metabolism. Also, the basal R.Q. was unaffected, a finding contradictory to that reported by Orisini, Waisman, and Elvehjem ('42).

The heat increment of the diet, when no riboflavin was supplemented to the deficient animal showed a progressive increasing difference between control and deficient rats as the deficiency became more acute, the difference being 80, 118, and 166 sm. cal. per gm. of food, the deficient rat showing the higher heat increment. In the moderate deficiency the control had a heat increment of 110 sm. cals. per gram of food less than its deficient pair mate, a difference that was statistically significant. Ariboflavinosis was not affected by the type of diet employed, whether it was high fat, high protein or high carbohydrate.

The respiratory quotient during the respiration trial was

not affected by the deficiency irrespective of the type of diet. A high carbohydrate diet gave an average R.Q. of 1.0, an observation that finds some agreement in the work of Talbot *et al* ('38).

IV. Conclusions

1. The absence of an adequate amount of riboflavin in the diet will impair the efficiency with which that diet is utilized for growth or increase in body weight.

2. Ariboflavinosis has neither a depressing nor stimulating effect on the running activity.

3. The composition of gains in riboflavin deficient and riboflavin supplemented rats, both fed to gain at equal rates, is not significantly different.

4. A riboflavin deficiency, *per se,* does not impair the digestibility of energy or nitrogen. If prolonged and acute, such a deficiency may effect the digestibility adversely.

5. When riboflavin is supplied at a sub-minimal amount, but at a level which will permit nitrogen retention, an increased urinary excretion of both energy and nitrogen is observed as compared to controls. When no nitrogen is retained no difference in nitrogen excretion is found. Such evidence is taken to support the conception that riboflavin is concerned in protein anabolism.

6. Neither the basal R.Q. nor the average R.Q. obtained during the heat production trial differed in control and deficient animals.

7. The average R.Q. on a high carbohydrate synthetic diet fed to rats averaged approximately unity during a 16 to 20 hour heat production trial.

8. An increase in the heating effect of the diet was observed in ariboflavinosis. Such a difference tended to increase as the acute ariboflavinosis progressed.

9. The effect of a riboflavin deficiency on metabolism was not influenced by the type of diet—high carbohydrate, high fat, or high protein—fed.

10. The data presented would tend to support the conception that the better balanced a diet is with respect to the immediate requirements of the animal, the smaller will be its heating effect and the larger will be its net energy.

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Vita

Joseph Bernsohn was born in New York, New York, March 21, 1914.

Institutions Attended

New York City School System, New York, New York, 1920-26.

Boys High School, Brooklyn, New York, 1926-30.

Undergraduate, Brooklyn College, Brooklyn, New York, 1931-38.

Graduate, University of Illinois, 1939-43.

Degrees

B. S., Brooklyn College, 1938.

M. S., University of Illinois, 1940.

Positions Held

Assistant in Animal Nutrition, University of Illinois, July 1942 to August 31, 1943.

Societies

American Chemical Society.